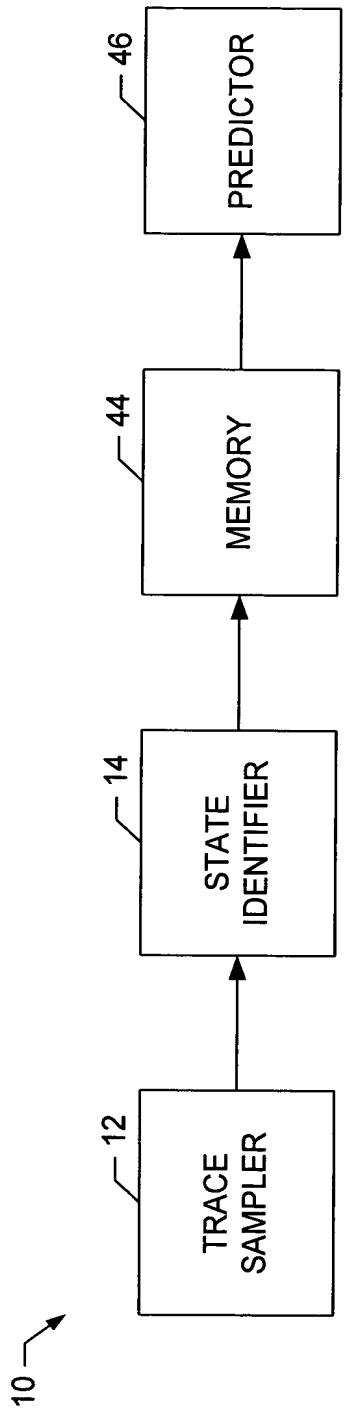

10
12
TRACE SAMPLER
14
STATE IDENTIFIER
44
MEMORY
46
PREDICTOR

FIG. 1

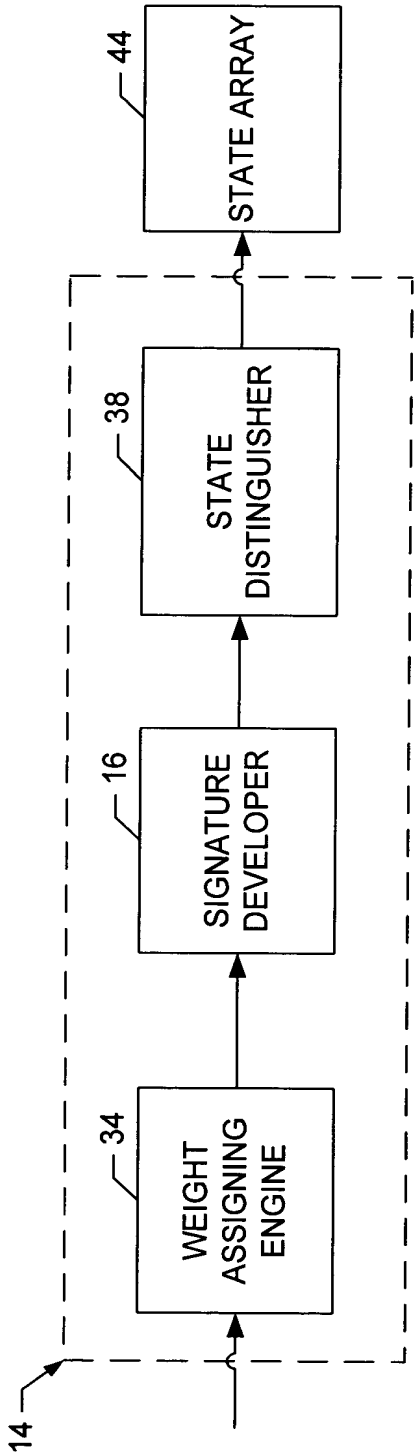

14
34
WEIGHT ASSIGNING ENGINE
16
SIGNATURE DEVELOPER
38
STATE DISTINGUISHER
44
STATE ARRAY

FIG. 2

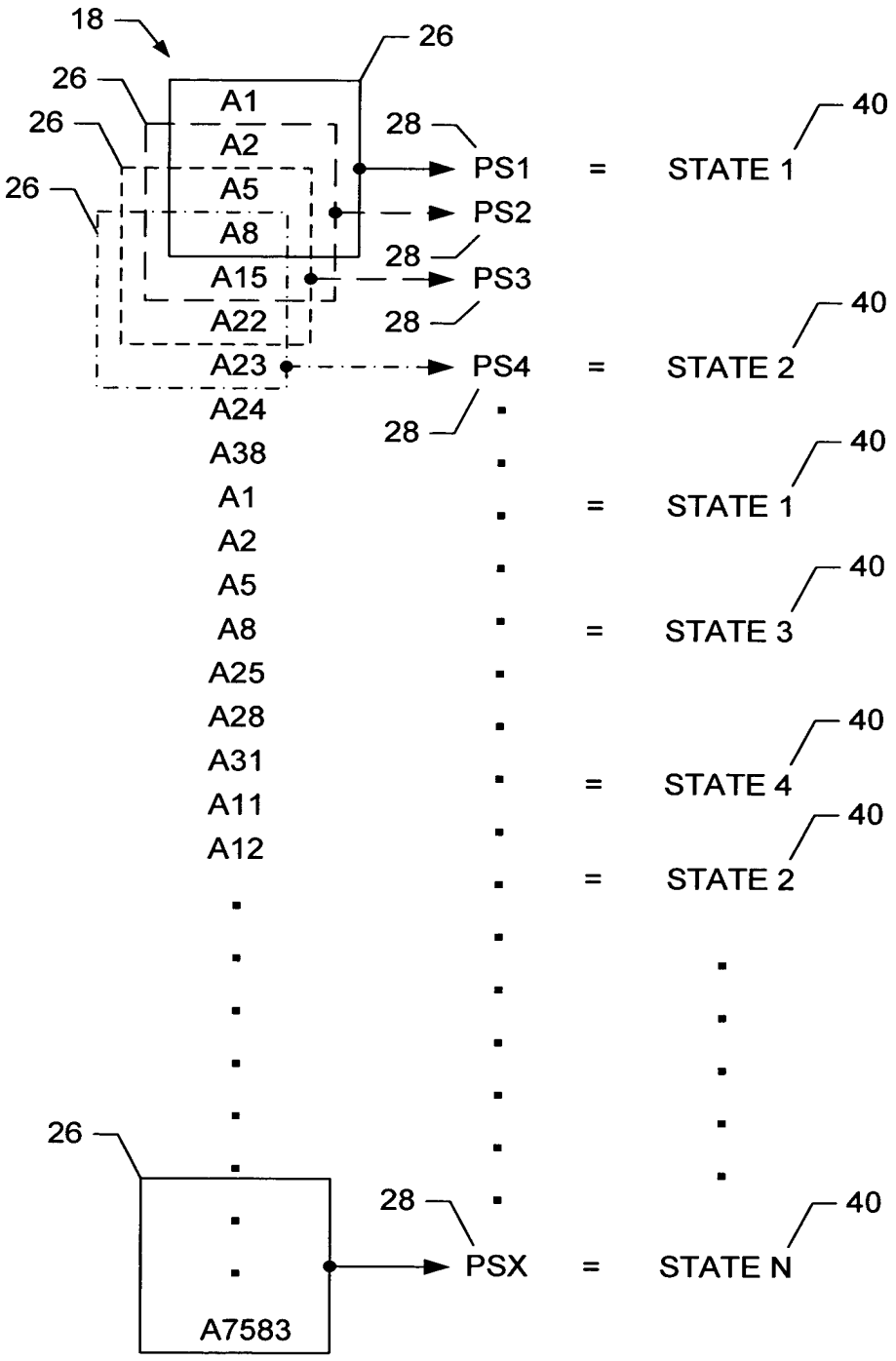

18
26
26
26
26
A1
A2
A5
A8
A15
A22
A23
A24
A38
A1
A2
A5
A8
A25
A28
A31
A11
A12
A7583
28
PS1
PS2
28
PS3
28
PS4
28
PSX
=
STATE 1
40
=
STATE 2
40
=
STATE 1
40
=
STATE 3
40
=
STATE 4
40
=
STATE 2
40
=
STATE N
40

FIG. 3

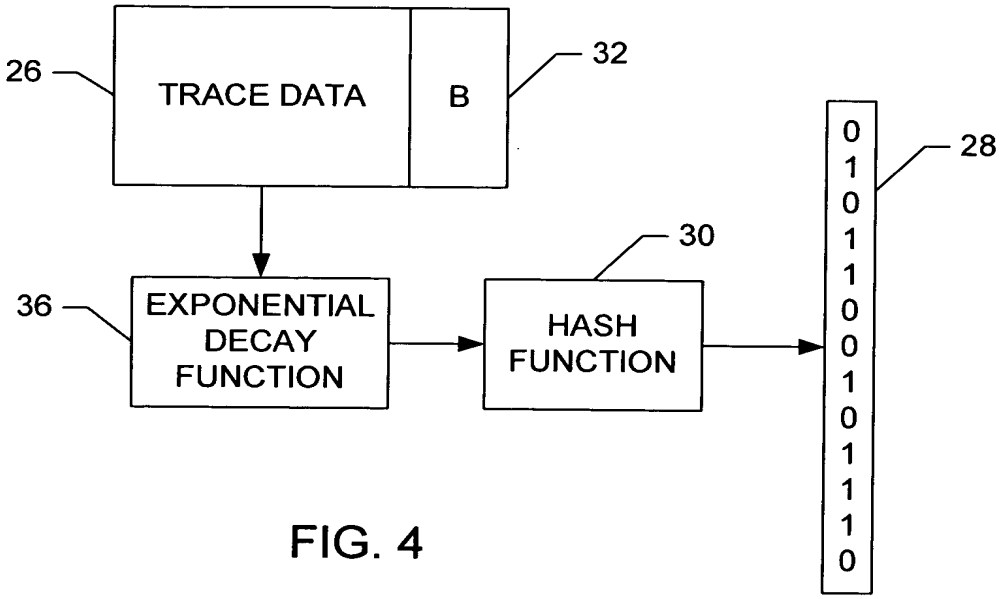

26
TRACE DATA
B
32
28
0
1
0
1
1
0
0
1
0
1
1
1
1
0
30
36
EXPONENTIAL DECAY FUNCTION
HASH FUNCTION

FIG. 4

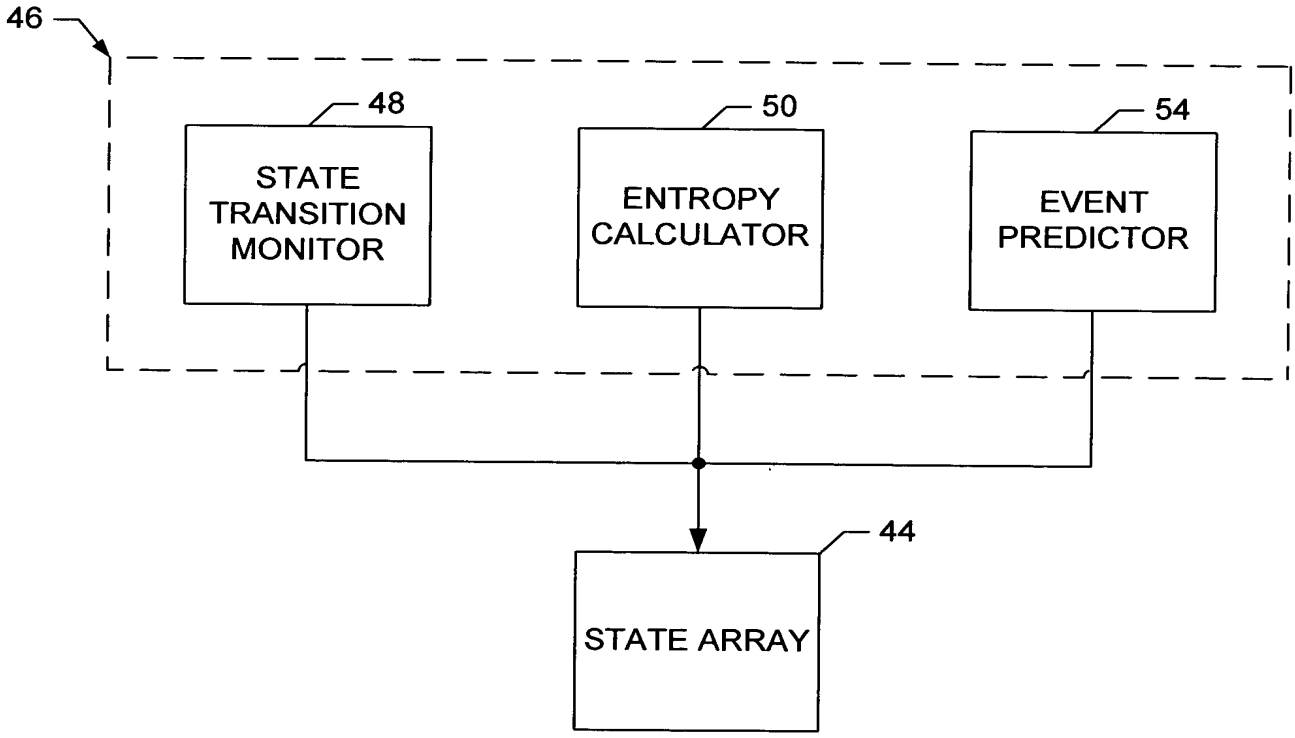

46
48
STATE TRANSITION MONITOR
50
ENTROPY CALCULATOR
54
EVENT PREDICTOR
44
STATE ARRAY

FIG. 6

STATE SIGNATURE:			0101100101110		
AGE:			X		
USAGE FREQUENCY:			Y		
ENTROPY:			Z		
STATE:	A	OCCURRENCE TIMES:	00:00:00; 00:05:13	PROBABILITY:	0.63
STATE:	C	OCCURRENCE TIMES:	00:02:04; 00:09:42	PROBABILITY:	0.12
STATE:	E	OCCURRENCE TIMES:	00:00:13; 00:02:43	PROBABILITY:	0.08
STATE:	G	OCCURRENCE TIMES:	00:08:06; 00:09:18	PROBABILITY:	0.05
STATE:	L	OCCURRENCE TIMES:	00:10:03	PROBABILITY:	0.02
STATE:	M	OCCURRENCE TIMES:	00:07:53	PROBABILITY:	0.02
. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .
STATE:	V	OCCURRENCE TIMES:	00:13:31; 00:15:37	PROBABILITY:	0.01

FIG. 5

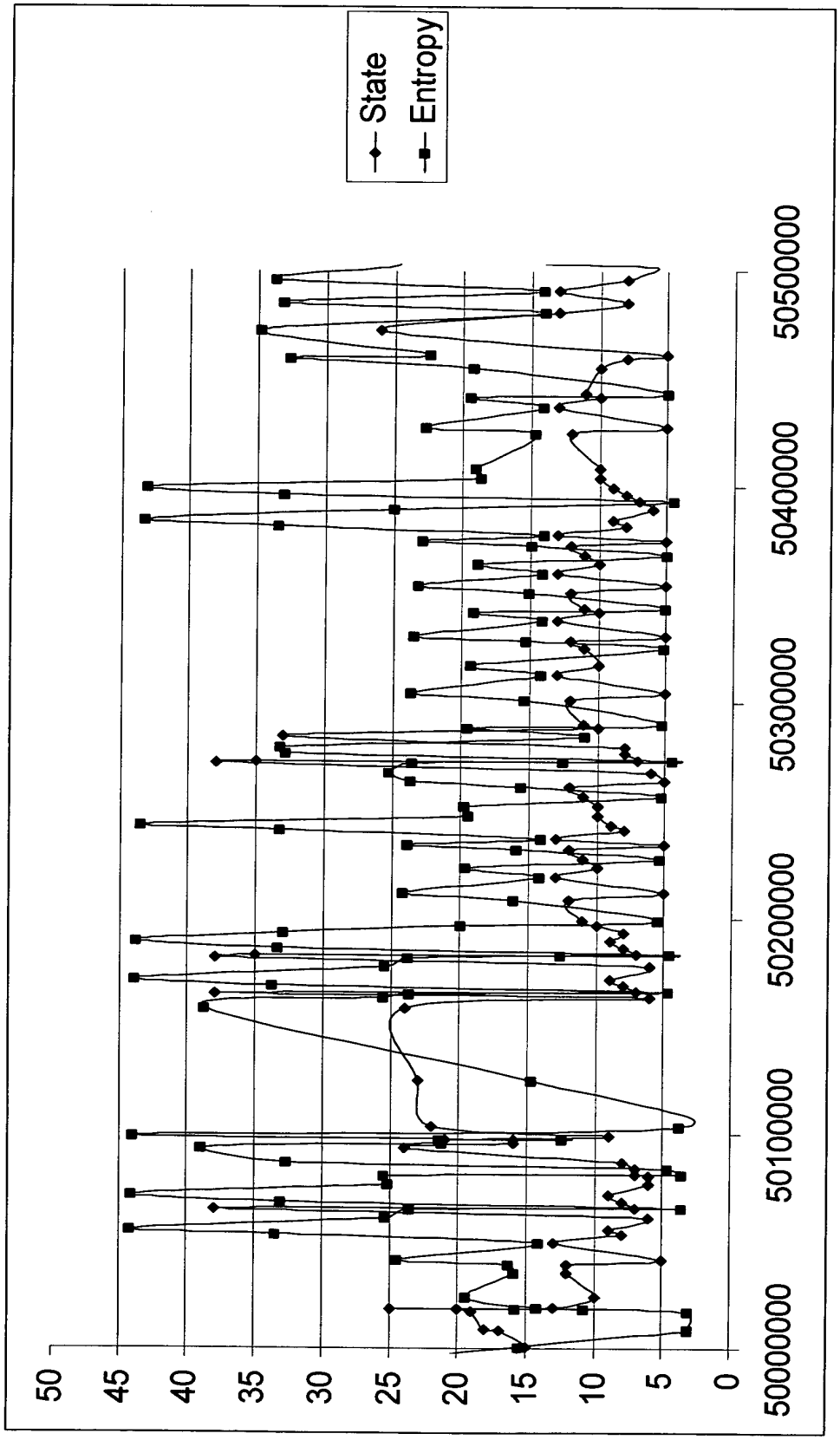
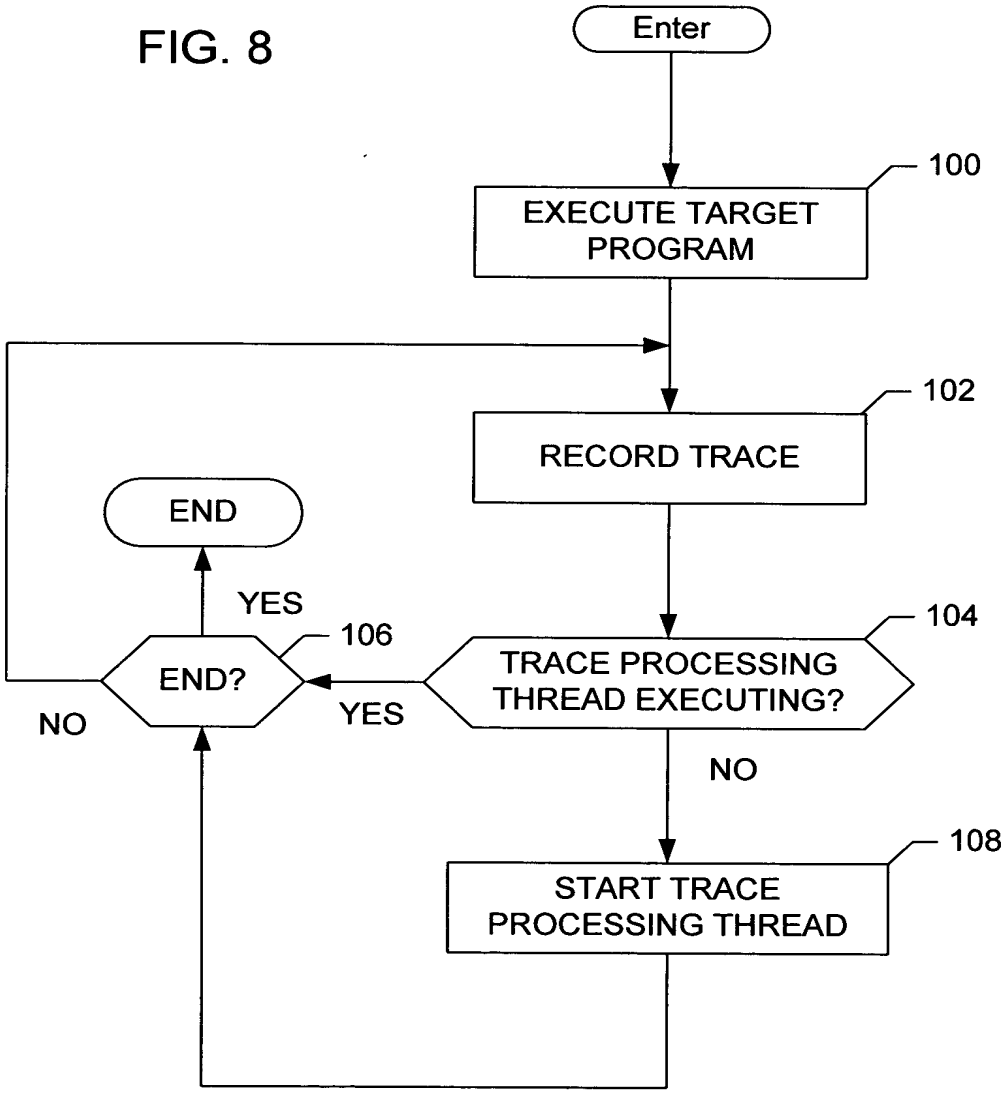

State
Entropy
50
45
40
35
30
25
20
15
10
5
0
50000000
50100000
50200000
50300000
50400000
50500000

FIG. 7

FIG. 8


Enter
EXECUTE TARGET PROGRAM
100
RECORD TRACE
102
END
YES
106
END?
NO
TRACE PROCESSING THREAD EXECUTING?
104
YES
NO
START TRACE PROCESSING THREAD
108

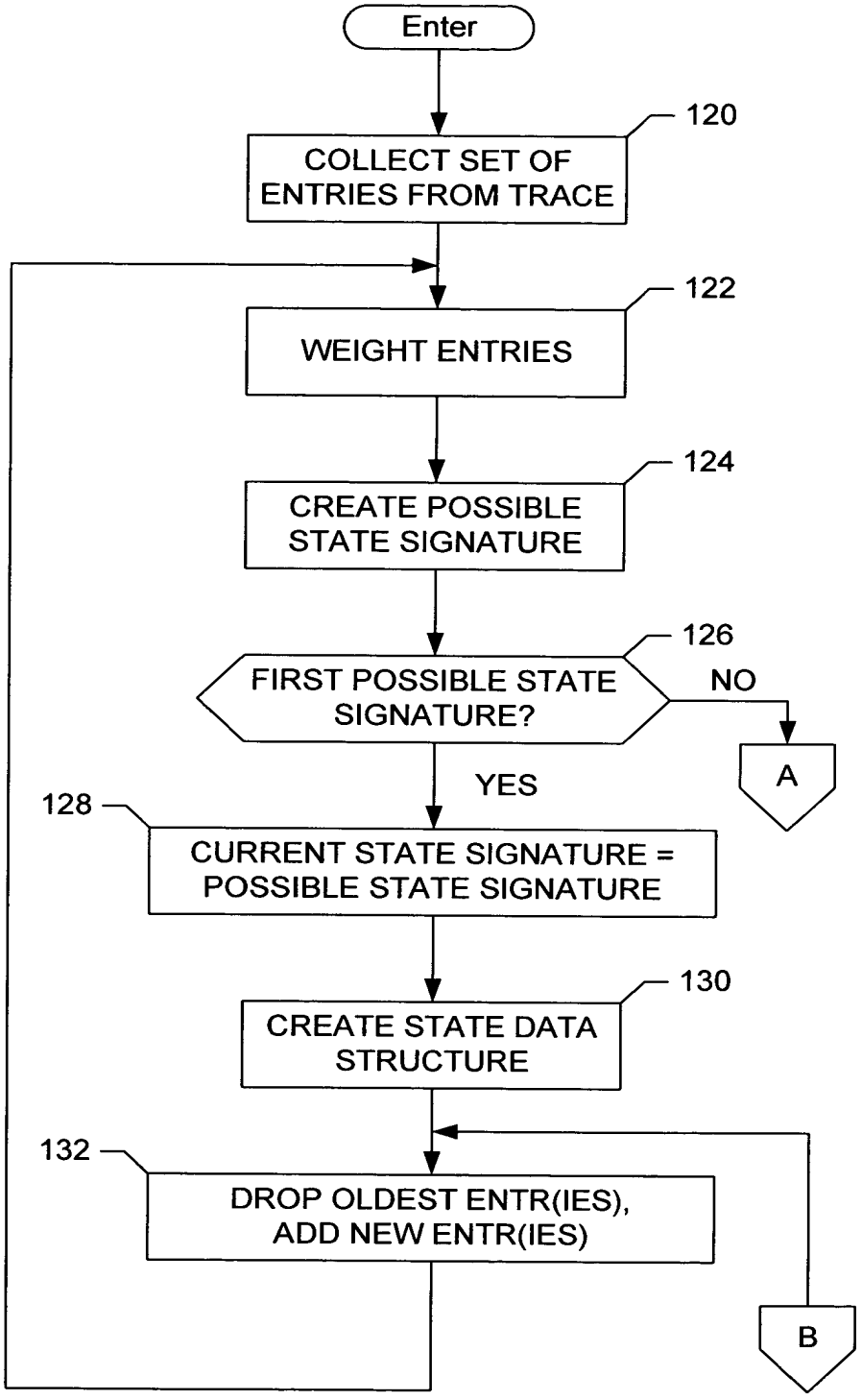

Enter
120
COLLECT SET OF ENTRIES FROM TRACE
122
WEIGHT ENTRIES
124
CREATE POSSIBLE STATE SIGNATURE
126
FIRST POSSIBLE STATE SIGNATURE?
NO
A
YES
128
CURRENT STATE SIGNATURE = POSSIBLE STATE SIGNATURE
130
CREATE STATE DATA STRUCTURE
132
DROP OLDEST ENTR(IES), ADD NEW ENTR(IES)
B

FIG. 9A

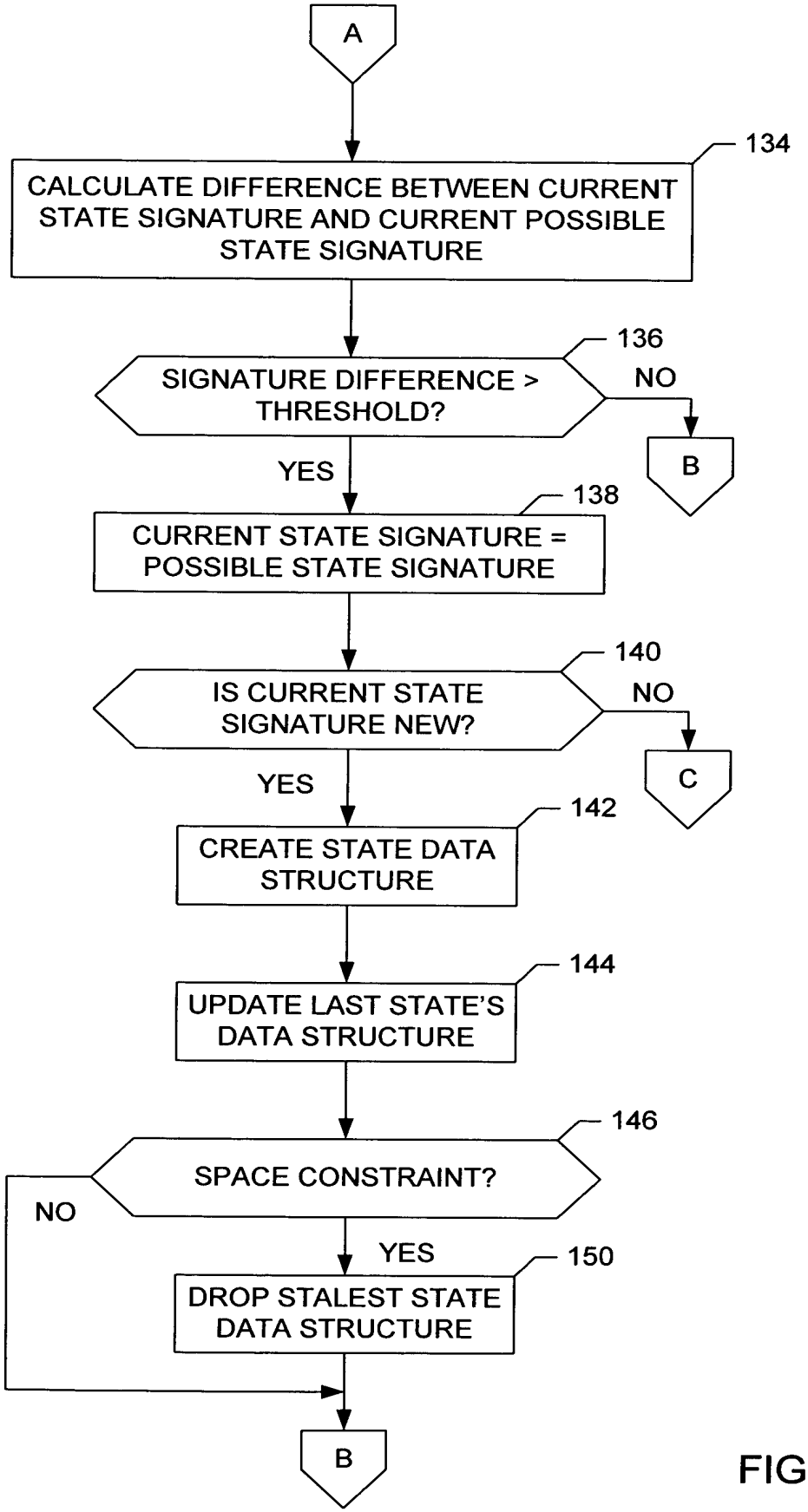

A
134
CALCULATE DIFFERENCE BETWEEN CURRENT STATE SIGNATURE AND CURRENT POSSIBLE STATE SIGNATURE
136
SIGNATURE DIFFERENCE > THRESHOLD?
NO
B
YES
138
CURRENT STATE SIGNATURE = POSSIBLE STATE SIGNATURE
140
IS CURRENT STATE SIGNATURE NEW?
NO
C
YES
142
CREATE STATE DATA STRUCTURE
144
UPDATE LAST STATE'S DATA STRUCTURE
146
SPACE CONSTRAINT?
NO
YES
150
DROP STALEST STATE DATA STRUCTURE
B

FIG. 9B

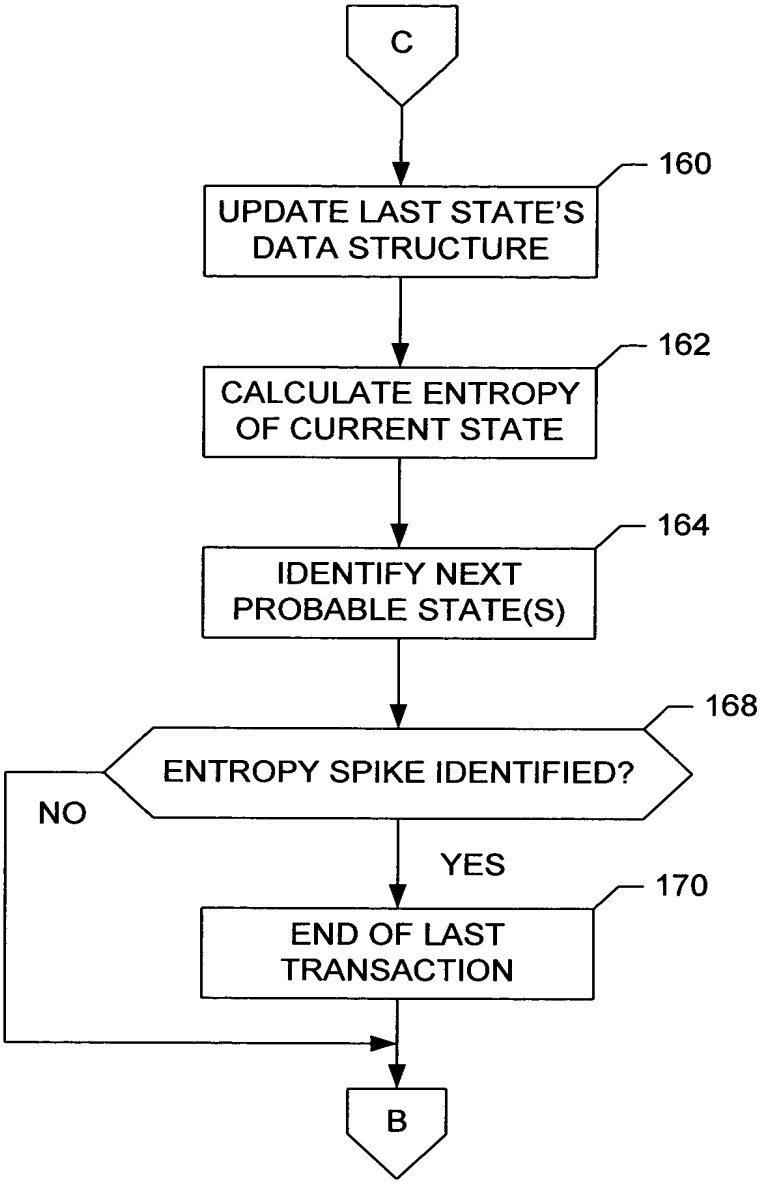

C
160
UPDATE LAST STATE'S DATA STRUCTURE
162
CALCULATE ENTROPY OF CURRENT STATE
164
IDENTIFY NEXT PROBABLE STATE(S)
168
ENTROPY SPIKE IDENTIFIED?
NO
YES
170
END OF LAST TRANSACTION
B

FIG. 9C

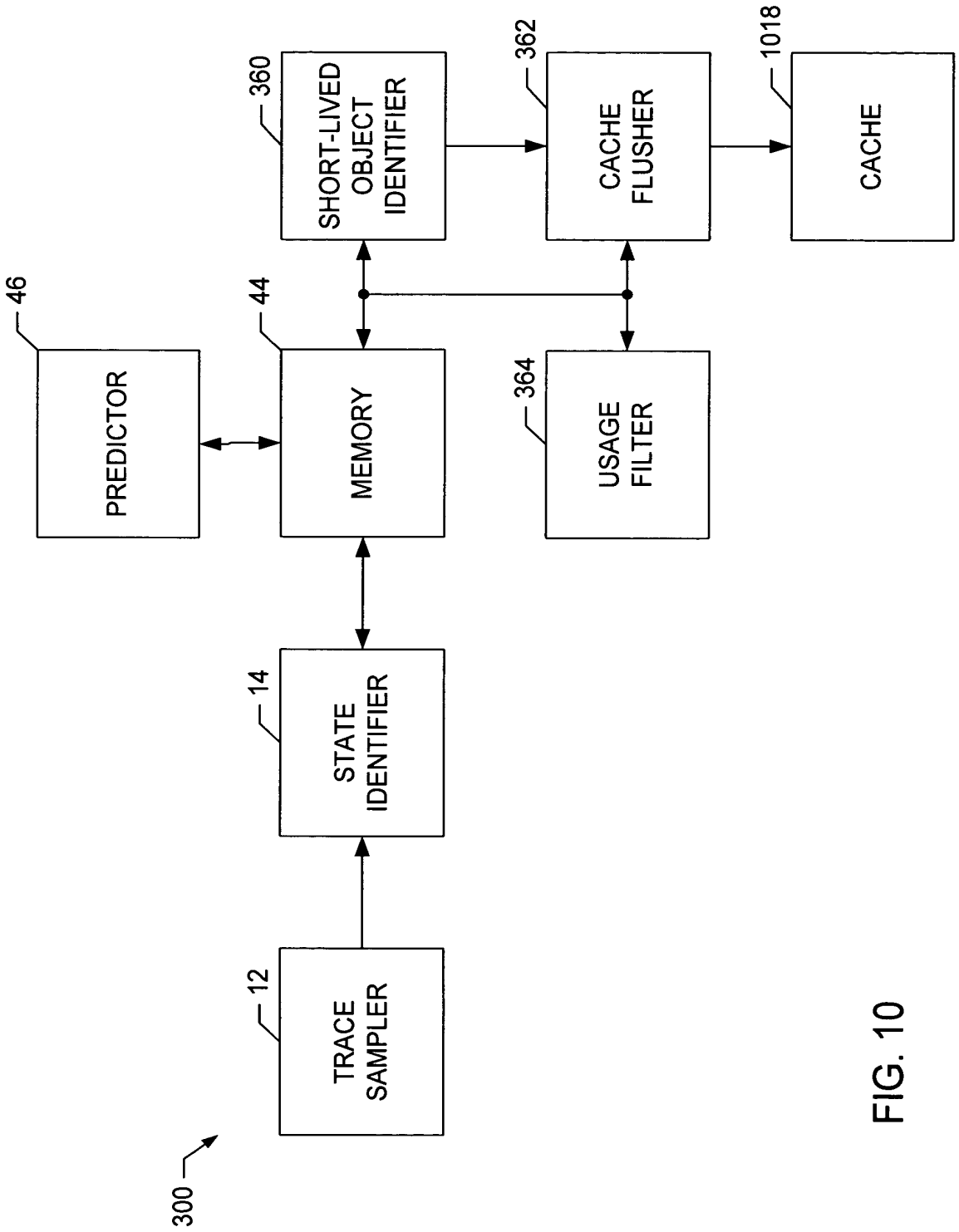

300
12
TRACE SAMPLER
14
STATE IDENTIFIER
44
MEMORY
46
PREDICTOR
360
SHORT-LIVED OBJECT IDENTIFIER
362
CACHE FLUSHER
364
USAGE FILTER
1018
CACHE

FIG. 10

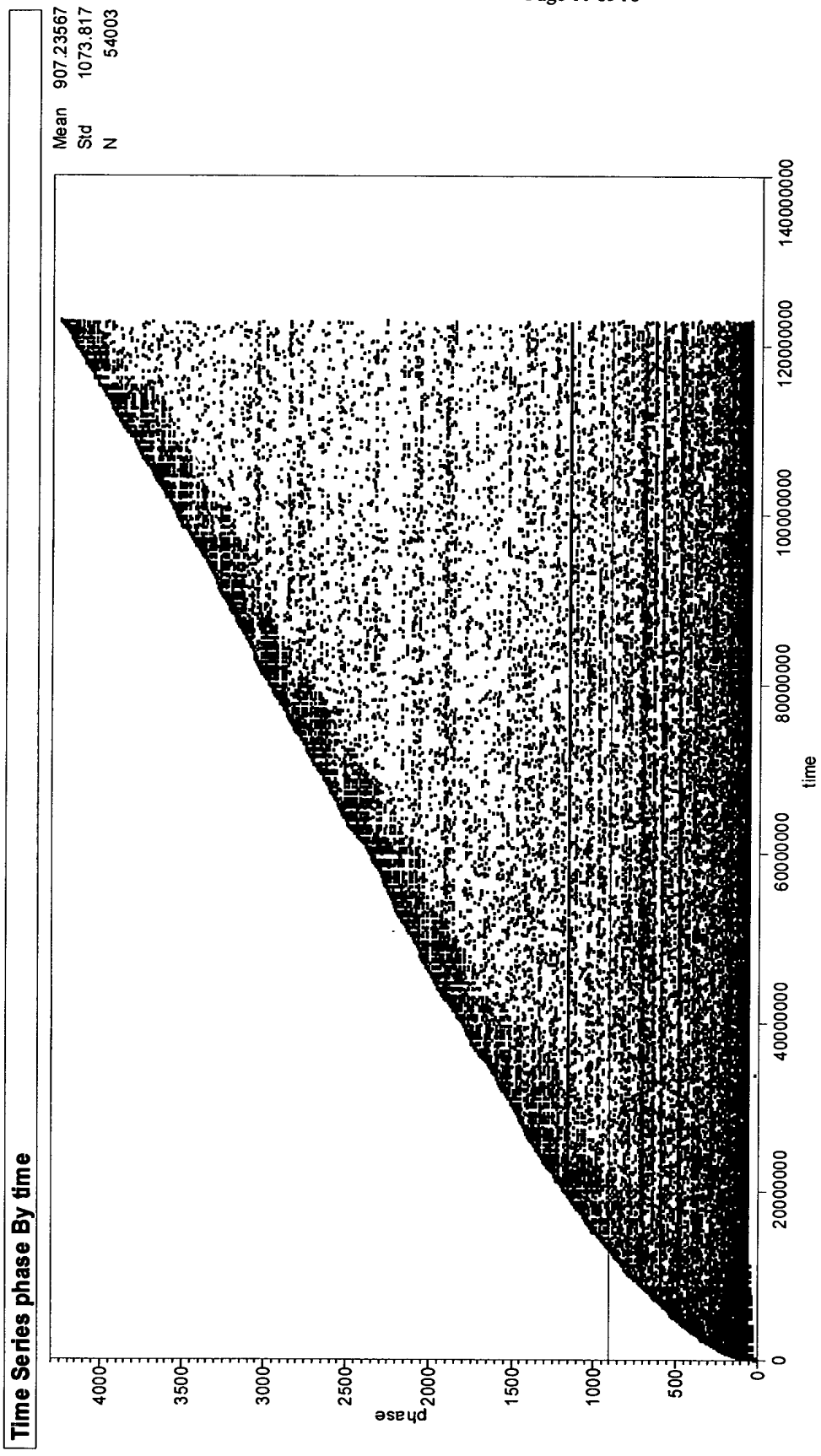

Time Series phase By time
Mean 907.23567
Std 1073.817
N 54003
phase
time
0
500
1000
1500
2000
2500
3000
3500
4000
0
20000000
40000000
60000000
80000000
100000000
120000000
140000000

FIG. 11

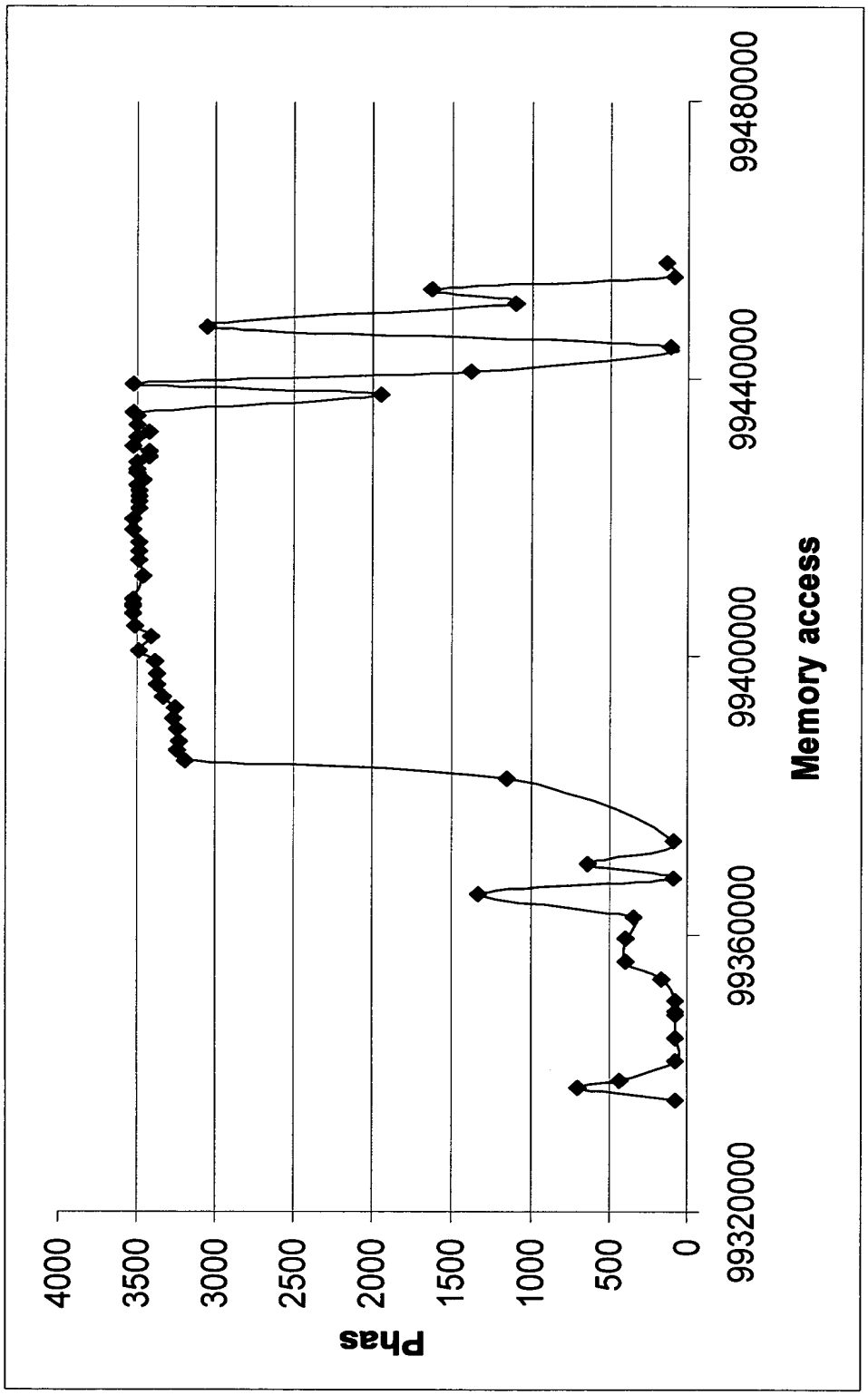

Phas
4000
3500
3000
2500
2000
1500
1000
500
0
99320000
99360000
99400000
99440000
99480000
Memory access

FIG. 12

STATE SIGNATURE:			0101100101110				
AGE:			X				
USAGE FREQUENCY:			Y				
ENTROPY:			Z				
STATE:	A	OCCURRENCE TIMES:	00:00:00; 00:05:13	PROBABILITY:	0.63		
STATE:	C	OCCURRENCE TIMES:	00:02:04; 00:09:42	PROBABILITY:	0.12		
STATE:	E	OCCURRENCE TIMES:	00:00:13; 00:02:43	PROBABILITY:	0.08		
STATE:	G	OCCURRENCE TIMES:	00:08:06; 00:09:18	PROBABILITY:	0.05		
STATE:	L	OCCURRENCE TIMES:	00:10:03	PROBABILITY:	0.02		
STATE:	M	OCCURRENCE TIMES:	00:07:53	PROBABILITY:	0.02		
. . .	. . .	. . .	. . .	. . .	. . .		
. . .	. . .	. . .	. . .	. . .	. . .		
. . .	. . .	. . .	. . .	. . .	. . .		
STATE:	V	OCCURRENCE TIMES:	00:13:31; 00:15:37	PROBABILITY:	0.01		
OBJECT REFERENCES:				A1	A3	A456	A358
A2	A47	A13256	A5432	A67834	A89045	A56732	A45098
A43	A33	A5623	A1234	A5432	A5678	A47890	A87
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
A764	A368	A412	A8345	A21	A54	A43876	A11

FIG. 13

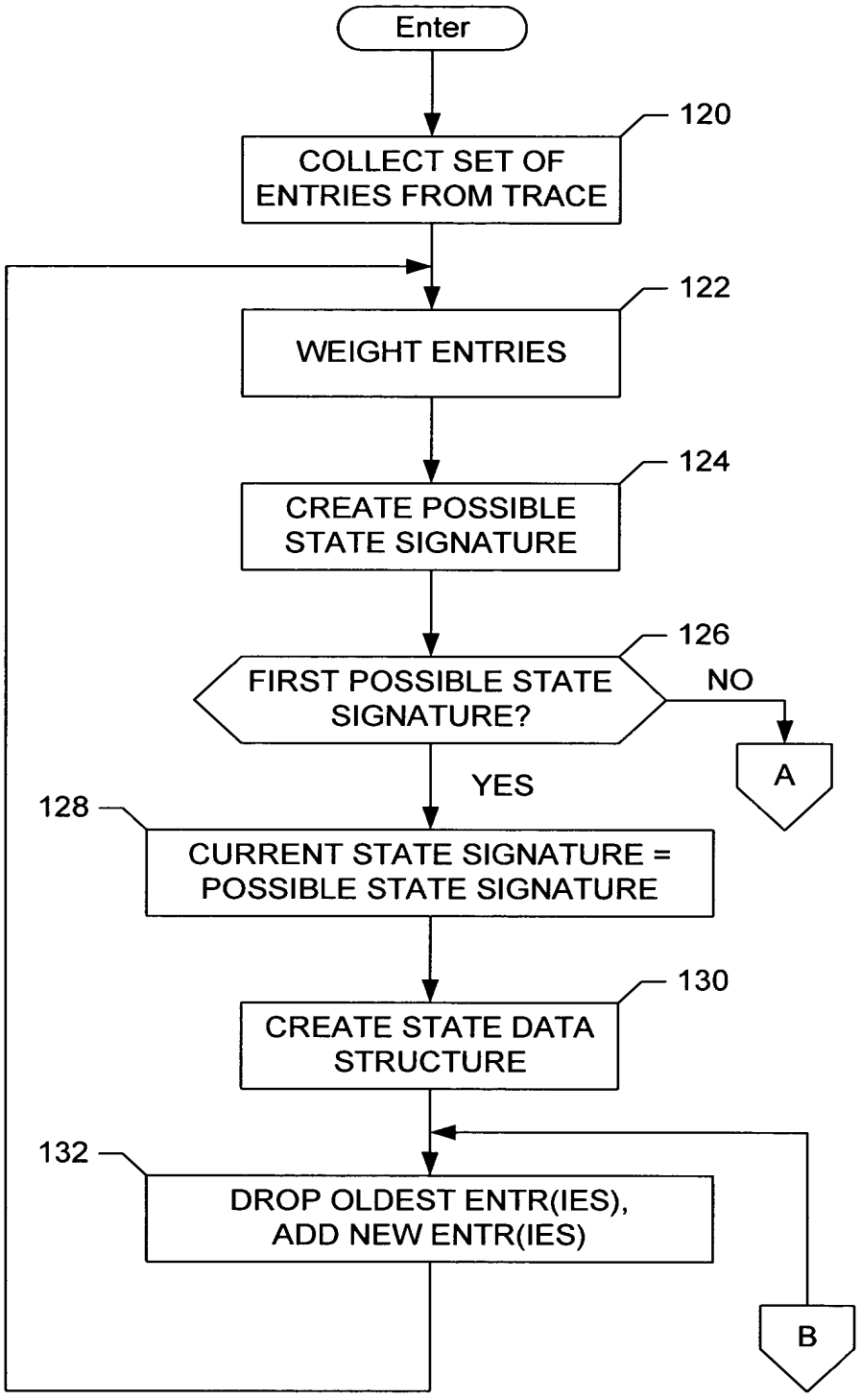

Enter
120
COLLECT SET OF ENTRIES FROM TRACE
122
WEIGHT ENTRIES
124
CREATE POSSIBLE STATE SIGNATURE
126
FIRST POSSIBLE STATE SIGNATURE?
NO
A
YES
128
CURRENT STATE SIGNATURE = POSSIBLE STATE SIGNATURE
130
CREATE STATE DATA STRUCTURE
132
DROP OLDEST ENTR(IES), ADD NEW ENTR(IES)
B

FIG. 14A

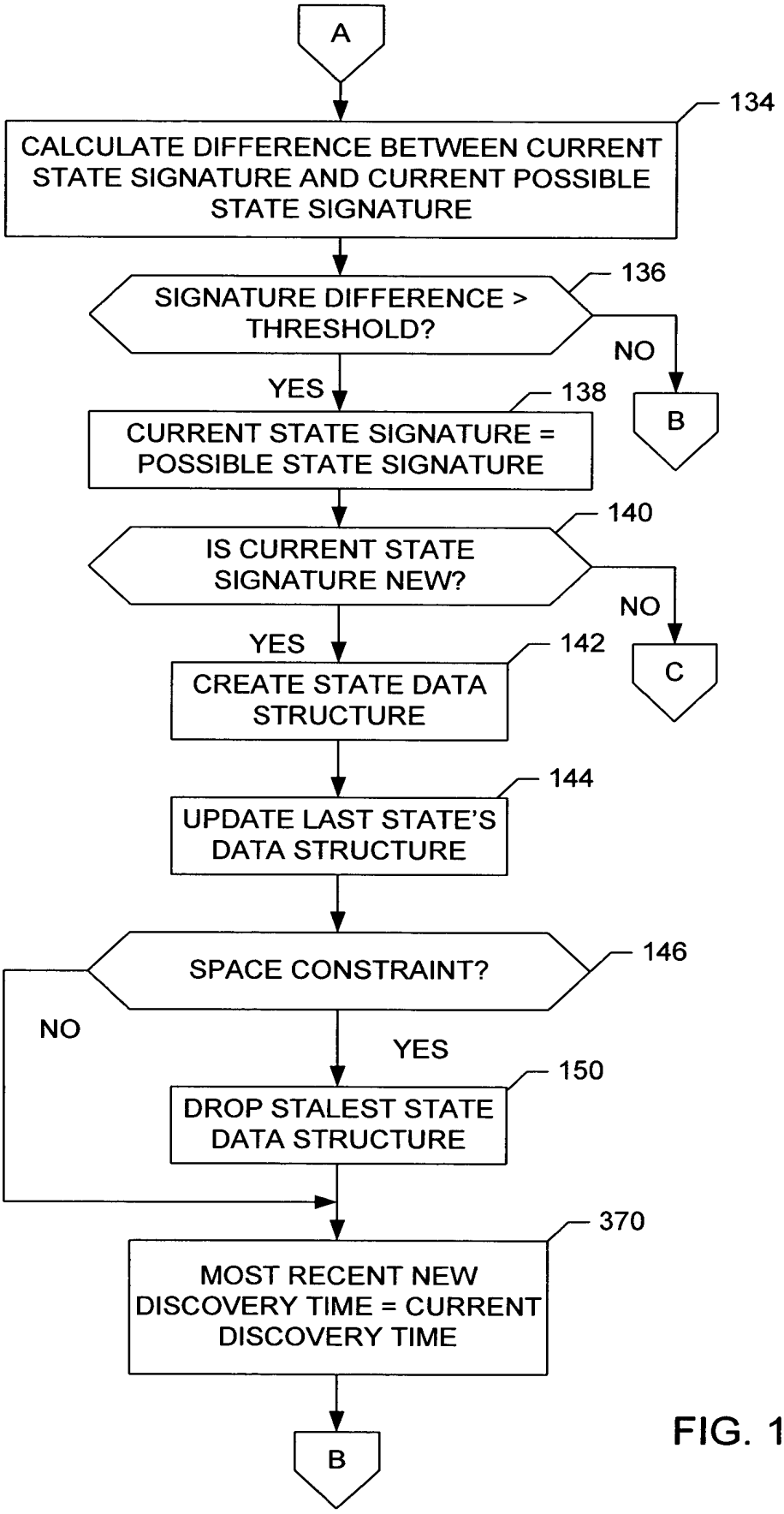

A
134
CALCULATE DIFFERENCE BETWEEN CURRENT STATE SIGNATURE AND CURRENT POSSIBLE STATE SIGNATURE
136
SIGNATURE DIFFERENCE > THRESHOLD?
NO
B
YES
138
CURRENT STATE SIGNATURE = POSSIBLE STATE SIGNATURE
140
IS CURRENT STATE SIGNATURE NEW?
NO
C
YES
142
CREATE STATE DATA STRUCTURE
144
UPDATE LAST STATE'S DATA STRUCTURE
146
SPACE CONSTRAINT?
NO
YES
150
DROP STALEST STATE DATA STRUCTURE
370
MOST RECENT NEW DISCOVERY TIME = CURRENT DISCOVERY TIME
B

FIG. 14B

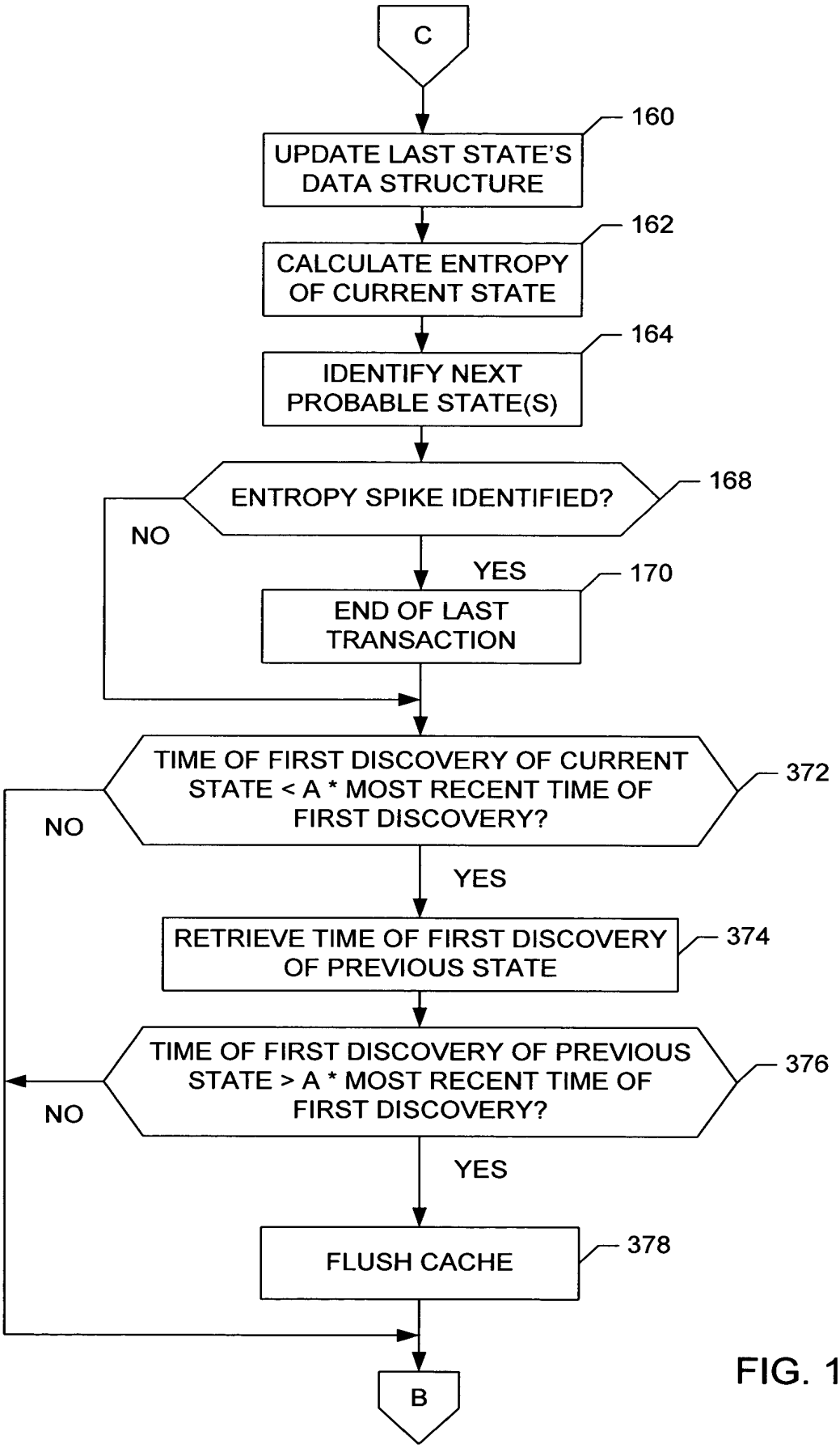

C
160
UPDATE LAST STATE'S DATA STRUCTURE
162
CALCULATE ENTROPY OF CURRENT STATE
164
IDENTIFY NEXT PROBABLE STATE(S)
ENTROPY SPIKE IDENTIFIED?
168
NO
YES
170
END OF LAST TRANSACTION
TIME OF FIRST DISCOVERY OF CURRENT STATE < A * MOST RECENT TIME OF FIRST DISCOVERY?
372
NO
YES
RETRIEVE TIME OF FIRST DISCOVERY OF PREVIOUS STATE
374
TIME OF FIRST DISCOVERY OF PREVIOUS STATE > A * MOST RECENT TIME OF FIRST DISCOVERY?
376
NO
YES
FLUSH CACHE
378
B

FIG. 14C

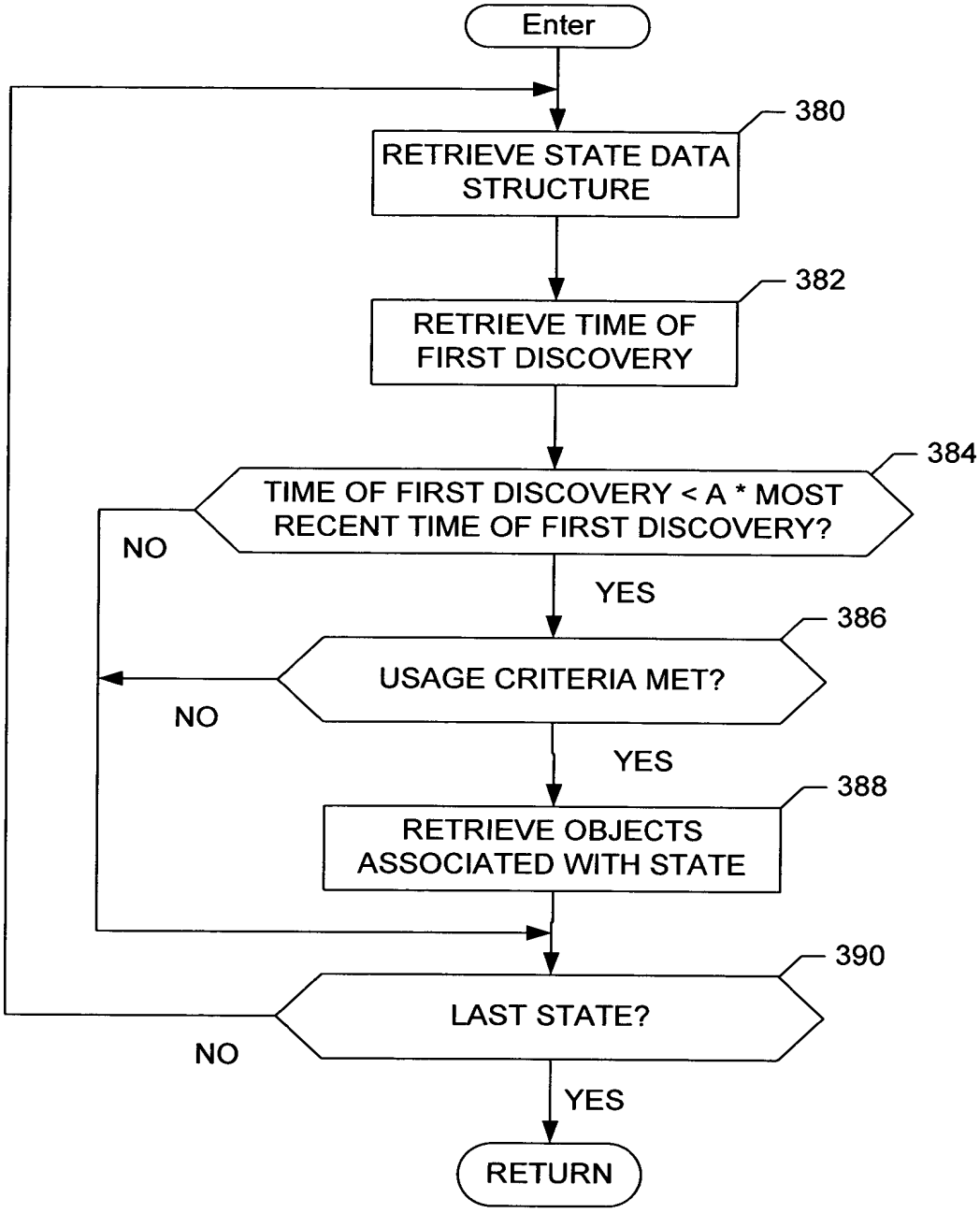
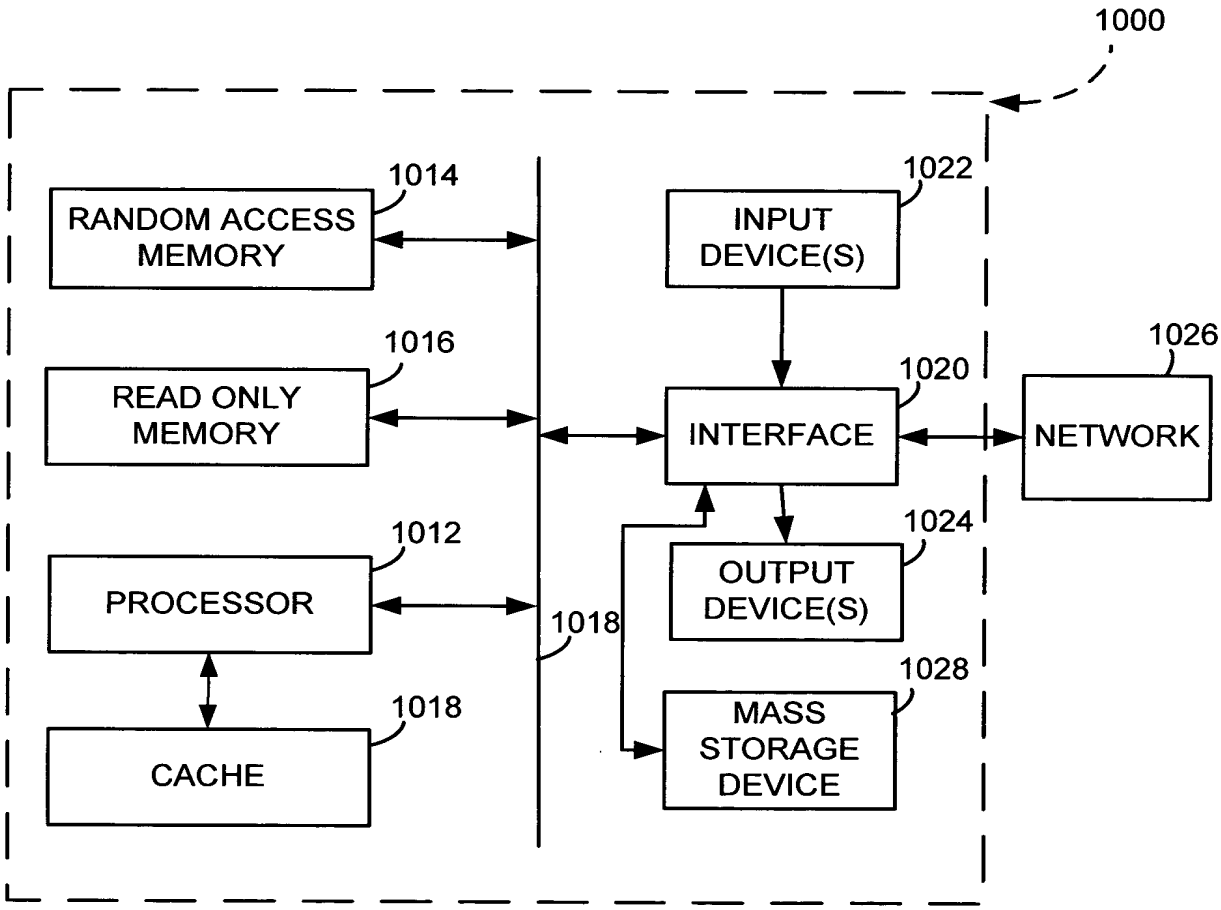

Enter
380
RETRIEVE STATE DATA STRUCTURE
382
RETRIEVE TIME OF FIRST DISCOVERY
384
TIME OF FIRST DISCOVERY < A * MOST RECENT TIME OF FIRST DISCOVERY?
NO
YES
386
USAGE CRITERIA MET?
NO
YES
388
RETRIEVE OBJECTS ASSOCIATED WITH STATE
390
LAST STATE?
NO
YES
RETURN

FIG. 15

FIG. 16


1000
RANDOM ACCESS MEMORY
1014
READ ONLY MEMORY
1016
PROCESSOR
1012
CACHE
1018
1018
INPUT DEVICE(S)
1022
INTERFACE
1020
OUTPUT DEVICE(S)
1024
MASS STORAGE DEVICE
1028
NETWORK
1026